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[ABSTRACT]

The present invention relates to a cathode ray tube of which outside surface is substantially flat and of which inside surface is curved, and more particularly, to a cathode ray tube with uniform brightness and much improved contrast for relieving visual discomfort of viewers. The panel for cathode ray tube includes a front glass panel of which inside surface is substantially flat and having a predetermined curvature, a fluorescent screen formed inside the panel, a shadow mask spaced apart from the fluorescent screen to function a color selection, an electron gun installed at neck portion of the panel, and a deflection yoke for vertically or horizontally deflecting the electron beam emitted from the electron gun, wherein a central portion has a transmission rate of less than 75%, a rate of the transmission rate at the central portion to the transmission rate at the diagonal portion is more than 59%, and an arbitrary point, P (x, y, z), on the outside surface of the panel satisfies a condition of $20,000mm \le \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \le 50,000mm$.

[REPRESENTATIVE DRAWING]

FIG. 3

[INDEX WORD]

Cathode ray tube, Panel

[SPECIFICATION]

[TITLE OF THE INVENTION]

PANEL FOR CRT

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a diagram explaining a structure of a known color cathode ray tube.

Fig. 2 is a diagram explaining an outside surface curvature of a panel of which ou tside surface is substantially flat for the known cathode ray tube.

Fig. 3 is a diagram explaining a curvature radius of a panel for a cathode ray tube according to the present invention.

<DESCRIPTION OF THE SYMBOLS IN MAIN PORTIONS OF THE DRAWINGS>

1: Panel	2: Funnel
3: Shadow mask	4: Mask frame
5: Spring	6: Stud pin
7: Inner shield	8: Electron gun
9: Deflection yoke	10: convergence purity correcting magnet
11: Electron beam	12: Reinforcing band
13: Fluorescent screen	

[DETAILED DESCRIPTION OF THE PRESENT INVENTION]

[OBJECT OF THE PRESENT INVENTION]

[FIELD OF THE INVENTION AND DESCRIPTION OF THE RELATED ART]

The present invention relates to a cathode ray tube of which outside surface is su bstantially flat and of which inside surface is curved, and more particularly, to a cathode ray tube with uniform brightness and much improved contrast for relieving visual discom

fort of viewers.

Fig. 1 is a diagram explaining the structure of an already-known color cathode ra y tube.

Referring to Fig. 1, the related art color cathode ray tube includes a front side gla ss panel 1, and a rear side glass funnel 2 welded to the panel 1. The panel 1 and the f unnel 2 are welded to each other in a manner that their inside is vacuum, thereby formin g a vacuum tube.

A fluorescent screen 13 is formed on the inside surface of the panel 1, and an el ectron gun 8 is mounted on a neck portion of the funnel 2 being opposed to the fluoresc ent screen 13.

A shadow mask 3 with a color selecting function is situated between the fluoresc ent screen 13 and the electron gun 8, maintaining a predetermined distance from the flu orescent screen 13, and the shadow mask 3 is supported by a mask frame 4. Also, th e mask frame 4, being elastically supported by a mask spring 5, is connected to a stud pin 6 to be supported to the panel 1.

The mask frame 4 is jointed with an inner shield 7 made of magnetic material to r educe the movement of an electron beam 11 due to external magnetic field when the ca thode ray tube is in the middle of operation.

On the other hand, a deflection yoke 9 for deflecting the electron beam 11 emitte d from the electron gun 8 is mounted into a neck portion of the funnel 2.

Also, a reinforcing band 12 is included in order to reinforce the front surface glas s under the influence of vacuum state of the inside the tube.

To explain the operation of thusly constructed color cathode ray tube, the electro n beam 11 emitted from the electron gun 8 is deflected vertically and horizontally by the deflection yoke 9, and the deflected electron beam 11 passes through a beam passing hole on the shadow mask 3 and strikes the fluorescent screen 13 on the front, consequ ently displaying a desired color image.

Particularly, the convergence purity correcting magnet 10 corrects convergence a

nd purity of the R, G, B electron beams 11, and the inner shield 7 shields the magnetic f ield from the rear side of the cathode ray tube.

Whether the panel 1 is explosion proof or has substantially good visibility is heavi ly dependent on how its inside and outside surface curvatures are formed. Especially, the inside surface curvature has a great impact on the sense of flatness of the screen a nd the presence of distortion of the image.

Further, transmission rate of the panel 1 plays a very important role for realizing a high quality cathode ray tube because the uniform brightness and high contrast are en tirely dependent upon the transmission rate of the panel 1.

Generally, the inside surface curvature of the panel can be expressed by a ratio (or Wedge) of a thickness of a diagonal end to a thickness at a central portion of the pan el. Compared with a cathode ray tube with a curved outside surface, of which wedge i s about 130%, a cathode ray tube having a substantially flat panel has a higher than 20 0% of wedge, meaning that the peripheral portion of this panel, particularly the thicknes s of a diagonal end, is extremely thick.

Fig. 2 is a diagram explaining the outside surface curvature of the panel of which outside surface is substantially flat.

As shown in Fig. 2, P (x, y, z) indicates a point on the substantially flat outside su rface of the panel. The outside surface curvature radius of the panel can be expresse d by the following mathematical formula I.

[Mathematical formula I]

$$\text{Curvature radius} = \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z}$$

The outside surface curvature radius of the panel with the substantially flat outsid e surface in the conventional cathode ray tube is approximately 100,000mm. One of st rong points of this type of panel is that since a viewer perceives the panel as flat, the se nse of flatness of the screen is secured and the viewer hardly sees distorted images.

On the other hand, when the wedge of the panel whose outside surface is substa

ntially flat gets high, e.g. greater than 200%, the thickness of the diagonal end becomes extremely large and this affects the contrast of brightness of images.

The following mathematical formula II represents the transmission rate of the panel.

[Mathematical formula II]

Transmission rate ™ = (1-Re)2 x e –kt x 100(%)

Where Re denotes a reflectivity of glass; k denotes absorbency index; and t denotes the thickness of glass.

As the above formula shows, as the wedge of the panel is increased, the ratio of the thickness of a diagonal end to the thickness at a central portion of the panel becomes great, and the difference between the transmission rate at the central portion of the panel and at the peripheral portion of the panel gets large. As a result, the brightness at the central portion and the peripheral portion will be much different from each other and the viewer would end up with visual discomfort.

As an attempt to solve this problem, some used a panel having at least 85% of transmission rate at the central portion, hoping to secure the uniformity of brightness without deteriorating the peripheral transmission rate.

Table 1 shows contrast rates (%) of the peripheral portion to the central portion and transmission rates (%) of the peripheral portion to the central portion, given illumination of an external light is 200lux (lx).

[Table 1]

Transmission rate of central portion (%)	Ratio of contrast of peripheral portion to central portion (%)	Ratio of transmission rate of peripheral portion to central portion (%)
90	14.0	98.7
85	14.9	93.2
80	16.0	87.8
75	17.1	82.3

70	18.4	76.8
65	19.7	71.3
60	21.1	65.9
55	22.6	60.4
50	24.2	54.9

In short, as the transmission rate of the central portion is improved, the ratio of th e transmission rate of the peripheral portion to the transmission rate of the central portio n is also improved but the ratio of the contrast of the peripheral portion to that of the cen tral portion is lowered.

To be short, although it is possible to secure the uniformity of brightness of imag es without reducing the transmission rate at the peripheral portion by using the panel ha ving a transmission rate at the central portion of the panel being higher than 85%, this al so gives rise to other problems, e.g. excessive brightness or bad contrast characteristic.

Especially when the contrast is bad and the cathode ray tube is operated in a pla ce where the illumination of the external light is greater than 200lux (lx), it becomes virtu ally impossible to obviate visual discomfort problem.

Introduced to overcome the above drawback is putting a coating or film on the pa nel. However, the method was not found very favorable because it required an extra p rocess and cost.

[TECHNICAL OBJECT OF THE INVENTION]

An object of the present invention is to provide a cathode ray tube with uniform br ightness and much improved contrast for relieving visual discomfort of viewers.

[CONSTITUTION AND OPERATION OF THE INVENTION]

To attain the above objects, a panel for cathode ray tube includes: a front glass p anel of which inside surface is substantially flat and having a predetermined curvature,

a fluorescent screen formed inside the panel, a shadow mask spaced apart from the fluorescent screen to function a color selection, an electron gun installed at neck portion of the panel, and a deflection yoke for vertically or horizontally deflecting the electron beam emitted from the electron gun, wherein a central portion has a transmission rate of less than 75%, a rate of the transmission rate at the central portion to the transmission rate at the diagonal portion is more than 59%, and an arbitrary point, P (x, y, z), on the outside surface of the panel satisfies a condition of $20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 50,000mm$.

The following detailed description will present a cathode ray tube according to a preferred embodiment of the invention in reference to the accompanying drawings.

Table 2 below shows how vertical heights (mm) at the central portion of the panel from a diagonal end of the effective surface and the ratio (%) of the transmission rate of the peripheral portion to the transmission rate at the central portion of the panel change in accordance with the outside surface curvature radius of the panel.

[Table 2]

Outside surface curvature radius of the panel (mm)	Vertical height at the central portion of the panel from diagonal end of the effective surface (mm)	Ratio of transmission rate at the peripheral portion to transmission rate at the central portion of the panel (%)
100,000	0.571	57.88
90,000	0.635	58.05
80,000	0.714	58.26
70,000	0.816	58.54
60,000	0.952	58.91
50,000	1.142	59.43
40,000	1.428	60.22

30,000	1.904	61.56
20,000	2.856	64.33
10,000	5.714	73.42

Table 2 shows that as the outside surface curvature radius of the panel is increased, the vertical height at the central portion of the panel from the diagonal end of the effective surface as well as the ratio of the transmission rate at the peripheral portion to the transmission rate at the central portion of the panel, i.e. peripheral transmission rate of the panel/central transmission rate of the panel, are reduced.

In case of the conventional panel whose outside surface is substantially flat, the outside surface curvature radius of the panel was about 100,000mm and the vertical height at the central portion of the panel was 0.571mm, and this was enough to improve the sense of flatness. Meanwhile, the wedge of the panel was higher than 220%, giving rise to a problem that the peripheral portion of the panel, especially the thickness of the diagonal end, got too thick is influenced.

Moreover, when the outside surface curvature radius of the panel is 20,000mm, the vertical height at the central portion of the panel from the diagonal end of the effective surface of the panel becomes 2.856mm, giving a satisfactory sense of flatness to viewers.

However, if $\frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z}$ is smaller than 20,000mm, the vertical height at the central portion of the panel from the diagonal end of the effective surface of the panel becomes 5.714mm, and this destroys the sense of flatness of the screen and distorts images on the screen.

On the other hand, if $\frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z}$ is greater than 50,000mm, the ratio of the transmission rate at the peripheral portion to the transmission rate at the central portion of the panel becomes less than 58.91%. In consequence, the brightness at the central

portion of the screen is much different from the brightness at the peripheral portion and visual discomfort occurs.

Therefore, the ratio of the transmission rate at the peripheral portion to the trans mission rate at the central portion of the panel should be at least 58.91% and more to b e able to relieve visual discomfort.

The ratio of the transmission rate at the peripheral portion to the transmission rat e at the central portion of the panel should be at least 59%

In short, as long as the condition that the arbitrary point, P (x, y, z), on the outsid e surface of the panel whose outside surface is substantially flat and inside surface has a designated curvature satisfies the condition of $20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 50,000mm$, there is no need to use a panel whose transmi ssion rate at the central portion is greater than 85% to adjust the ratio of the peripheral t ransmission rate to the central transmission rate and put a coasting over the panel or att ach a film to the panel to improve the contrast of the screen.

In case of the conventional panel whose outside surface is substantially flat, the outside surface curvature radius of the panel was about 100,000mm and the vertical hei ght at the central portion of the panel was 0.571mm, and this was enough to improve th e sense of flatness. Meanwhile, the wedge of the panel was higher than 2.2, giving ris e to a problem that the peripheral portion of the panel, especially the thickness of the di agonal end, got too thick, and as a result, the uniformity of brightness was not maintaine d.

In addition, the ratio of the transmission rate at the peripheral portion to the trans mission rate at the central portion of the panel was 57.88%, which is very large. Again, the brightness at the central portion was much different from the peripheral portion, ca using visual discomfort.

Fig. 3 is a diagram explaining the curvature radius of the panel for the cathode ra y tube according to the present invention.

Referring to Fig. 3, the outside surface of the panel is substantially flat and the in side surface of the panel is curved. Given that there is an arbitrary point, P (x, y, z), on the outside surface of the panel, the point satisfies a condition of

$$20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 50,000mm$$

In other words, the ratio of the transmission rate at the peripheral portion to the tr ansmission rate at the central portion of the panel is increased by 1.55-6.45% when the curvature radius R of the outside surface satisfies 200,000mm≤R≤50,000mm.

By making the wedge rate of the panel in the range of 180-190%, it is possible to prevent the diagonal end from being excessively thick and to solve the difference of bri ghtness at the central portion and peripheral portion of the panel.

That is, in the panel of which outside surface is substantially flat, it is possible to solve the visual discomfort due to the difference of brightness at the central portion and the peripheral portion of the panel cased by the thickness difference at the central portio n and the diagonal end of the panel.

In this way, the contrast of the screen can be greatly improved as well.

More preferably, the arbitrary point, P (x, y, z), on the outside surface of the pane l satisfies a condition of $20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 25,000mm$, whereby the ratio of th e transmission rate at the peripheral portion to the transmission rate at the central portio n of the panel can be maintained at approximately 63-64.33% and the thickness of the diagonal end of the panel does not get extremely thick.

Also, an arbitrary point, Q (x, y, z), on the inside surface of the panel preferably s atisfies a condition of $3,500mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 5,000mm$.

If $\frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z}$ is greater than 5000mm, the slot space of the shadow mask i

ncreases and resolution is deteriorated. On the other hand, if $\frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z}$ is small er than 3500mm, the diagonal end of the panel gets too thick and the contrast between the central portion and the peripheral portion of the screen becomes severe.

In addition to the electron gun using the hot cathode, the electron emission unit u sing the cold cathode can be used.

The foregoing embodiments and advantages are merely exemplary and are not t o be construed as limiting the present invention. The present teaching can be readily a pplied to other types of apparatuses. The description of the present invention is intend ed to be illustrative, and not to limit the scope of the claims. Many alternatives, modific ations, and variations will be apparent to those skilled in the art. In the claims, means-pl us-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures.

[EFFECT OF THE INVENTION]

According to the present invention, the cathode ray tube can secure uniform brig htness and much improve contrast for relieving visual discomfort of viewers.

WHAT IS CLAIMED IS:

1. A panel for a cathode ray tube, comprising:

a front glass panel;

a funnel joined to the panel to maintain the inside in a vacuum; and

an electron emission unit,

wherein a central portion has a transmission rate of less than 75% and an arbitra ry point, P (x, y, z), on the outside surface of the panel satisfies a condition of

$$20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 50,000mm$$

2.

The panel according to claim 1, wherein the arbitrary point, P (x, y, z), on the out side surface of the panel satisfies a condition of

$$20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 25,000mm$$

3.

The panel according to claim 1, wherein the arbitrary point, Q (x, y, z), on the out side surface of the panel satisfies a condition of $3,500mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 5,000mm$.

4.

The panel according to claim 1, wherein the ratio of the thickness at the central p ortion of the panel to the thickness of the diagonal end is 180-190%.

5. A panel for cathode ray tube, comprising:

a front glass panel of which inside surface is substantially flat and having a prede

termined curvature, a fluorescent screen formed inside the panel, a shadow mask spac ed apart from the fluorescent screen to function a color selection, an electron gun install ed at neck portion of the panel, and a deflection yoke for vertically or horizontally deflect ing the electron beam emitted from the electron gun, wherein a central portion has a tra nsmission rate of less than 75%, a rate of the transmission rate at the central portion to the transmission rate at the diagonal portion is more than 59%, and an arbitrary point, P (x, y, z), on the outside surface of the panel satisfies a condition of

$$20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 50,000mm$$

6.

The panel according to claim 5, wherein the arbitrary point, P (x, y, z), on the out side surface of the panel satisfies a condition of

$$20,000mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 25,000mm$$

7.

The panel according to claim 5, wherein the arbitrary point, Q (x, y, z), on the out side surface of the panel satisfies a condition of $3,500mm \leq \frac{(\sqrt{x^2+y^2})^2+z^2}{2\times z} \leq 5,000mm$.

8.

The panel according to claim 5, wherein the ratio of the thickness at the central p ortion of the panel to the thickness of the diagonal end is 180-190%.